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# The challenge of retrieving the sub-mesoscale variability of precipitation from passive space-borne instruments

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Quantitative precipitation estimation products derived from passive satellite observations (microwave and infrared) have proven their utility and are now widely used for various applications ranging from climate studies to hydrological modeling. While the numerous available products show similar climatic patterns at the global scale and generally agree well with each other and with ground-based observations and model reanalyses at coarse resolutions, large uncertainties persist when it comes to reproducing the sub-mesoscale variability of precipitation (typically, hourly and sub-hourly temporal scales and spatial scales finer than 100 km). In fact, when compared to radar precipitation fields, most precipitation product relying on passive instruments are found to partially erase the sub-mesoscale variability, resulting in smooth precipitation fields. Beside the limited resolution of the instruments and the limited temporal sampling of the observations, the scale dependence in the relations between the measured radiances and precipitation make the retrieval of the fine-scale variability particularly challenging. For example, for microwave observations at 40 GHz, we find that the ice-scattering signal dominates the fine-scale variability of the observed brightness temperature while its coarse-scale variability is dominated by the emission signal from liquid rain drops. Additionally, the observation geometry may induce an uncertainty of the order of few kilometers to few tens of kilometers on the origin of the measured signals.
We propose to improve the retrieval of the fine-scale variability of precipitation from passive microwave by using information derived from the spatial patterns of the brightness temperature fields instead of using pixel-wise relations between brightness temperatures and precipitation as is classically done. This new “nonlocal” approach of the retrieval offers a framework allowing to better constrain the fine-scale variability of the retrieved precipitation fields. The preliminary results show reduced magnitude of the retrieval errors and less smooth precipitation field for the “nonlocal” retrieval compared to the classical pixel-wise retrieval.